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Research conducted over the past 80 years is examined to answer three questions on sensory modality as it relates to reading. In the 18 studies reviewed which relate to the superiority of one modality over another, there was no consensus regarding the relative effectiveness of modalities among adults. The evidence leans toward greater effectiveness of the visual modality among children. The review of eight studies which compared the effectiveness of the simultaneous use of more than one modality with the use of one modality alone revealed a problem in the definitions of modalities as used by different investigators. The results of these studies, however, generally support a combination of visual and auditory modes. Eight studies are reviewed which relate modality to reading ability. These studies suggest that while modality and perceptual skills are very important as factors in the early stages of reading instruction, cognitive abilities are more significant during the middle elementary grades. References are included. (RJ)

VISUAL AND AUDITORY MODALITIES:

HOW IMPORTANT ARE THEY?

By

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VISUAL AND AUDITORY MODALITIES: HOW IMPORTANT ARE THEY?

The current issue with which we are here concerned is that of the visual and auditory modalities. Very often, however, so-called "current issues" have longer histories than is presumed at first glance.

For approximately eighty years, questions have been raised in this country concerning the importance of the various modes of learning, particularly the auditory and visual modes. Among the most frequently asked questions have been: Is one modality more effective than another for learning? Is the simultaneous use of two or more modalities more effective than using one modality alone? Is changing from one modality to another in presenting the same material more or less effective than calling upon just one modality? Are there individuals who are inherently audile, visile, or kinesthetic? What part, if any, does age play in modal preference? Do poor readers have modal characteristics which are in any way different from the modal characteristics of good readers?

Before starting to trace the literature relating to these questions, the thought arose that the number of available studies might be rather thin, and that the inclusion of relevant data regarding factors of auditory and visual functioning might be necessary in order to fill out the paper. The reverse, of course, is true. Actually, a great deal of investigation of the modalities has taken place, and, although reference to the functioning of the senses would be useful in any discussion of the modalities, the major problem has been to select representative, cited examples from among the many modal investigations and then to group these selections sensibly in order to facilitate examination of comparable studies.

In grouping the studies, it was found that investigators have tended to examine one or more of five major questions. Although all five questions are related to reading, due to lack of space

we will deal with only three of them in this paper and leave the questions of inherent modal types and of transfer of modalities for another time.

In the first category we will examine, the superiority of one modality over another was studied. Usually, the auditory and visual modalities were thus compared. An example in detail of such a study is that of Münsterberg (17). In 1894, he reported the first of a series of experiments which was part of a systematic study of memory at the Harvard Experimental Laboratory. Five adult male subjects were presented with a series of colors and a series of numbers. They were then given papers with the names of the numbers and the colors written on them. Their task was to arrange the written numbers and colors in the order of the presented series. The visual presentation was in the form of squares of colored papers and white cards on which the numbers were written in black. The auditory presentation was given by the investigator saying the names of the colors or numbers. There was also an auditory-visual presentation in the form of simultaneous saying and showing of items. There were thirty-two different kinds of series, consisting of various combinations of colors and numbers and of modal presentations. The experiment took place for a total of fifty hours for each subject, during the winter of 1892-1893. Variables of fatigue, training and practice were controlled. There were no tests of significance and the conclusions of the investigator were based on inspection of the percentages of errors made. However, despite this lack of reported levels of significance, and despite the dismissal of the results of early studies by later investigators such as Van Mondfrans and Travers (24) because of this lack, Münsterberg's data is extremely clear, and it is rather simple to apply tests of which were non-existent in 1894. Münsterberg's conclusion that "With all the subjects, the visual memory excels strongly the aural when they act independently" is validly based on

his data. His conclusion becomes even more valid when the trends for each of his five subjects are examined and the results are extrapolated for larger n's.

Some other investigators who, using adult subjects and various verbal and non-verbal stimuli, also found that the visual mode was clearly more effective than the auditory mode for their subjects include Hawkins in 1897 (7), who used names of objects, Calkins in 1898 (4), who used words and pictures, and Beik (1), in 1962, who used audio and video advertisements.

Different results for adult subjects were reported by other investigators. Kirkpatrick (13) in 1894 compared visual and auditory presentation of words and pictures and found that there was no difference in results whether the auditory or the visual mode was used. The ability to recall pictures, however, was greater than the ability to recall words, no matter which mode was used. Other researchers who found no difference when visual and auditory modes were tested include Quantz in 1897 (21), who used one syllable words, and O'Brien in 1921 (18), who used words and nonsense syllables.

Henmon, however, in 1912 (8), concluded that, with concrete nouns, two-place numbers, and nonsense syllables, the auditory mode was markedly superior for his adult subjects, whether the mode was used alone or in combination with kinesthetic modes. Unfortunately, in his report, Henmon neglected to give the precise numerical data upon which he based his conclusions. However, in 1967, using ninth and twelfth graders, Cooper and Gaeth (5) also found that the auditory mode was more effective than the visual mode with both nonsense and meaningful paired associates.

Examination of the preceding reports indicates that there is obviously no consensus regarding the relative effectiveness of the auditory and visual modalities among adults.

Studies have also been done comparing the effectiveness of the auditory and visual modalities among children. Hawkins (7), who had found that the visual mode was more effective for his adult population, presented the same noun stimuli to children ranging from eight to twelve years of age. He found that, for these younger subjects, the auditory mode was more effective at each age, particularly for the eight to twelve year olds. Unfortunately, he did not indicate the number of subjects he used in his study.

Although few other researchers who used child subjects compared the two modalities over such a wide range of ages, the results of the other studies often varied considerable from those of Hawkins. In agreement with him for even younger subjects, however, Budoff and Quinlan (3) in 1964 concluded from their study of the learning of paired associate words by fifty-six second-graders that the auditory mode is significantly more rapid and effective for learning meaningful material than is the visual mode among primary grade children.

In 1966, for the same second grade level, Hill and Hecker (9), who referred back to Budoff and Quinlan's investigation with verbal stimuli, found that when the visual presentation was in the form of pictures rather than words, neither the auditory nor the visual modality was more effective. This relatively greater ease of learning pictures rather than words had been noted earlier by Kirkpatrick (13) and by Calkins (4).

For fourth graders, Lockhard and Sidowski (15) in 1961 found that in the learning of lists of nonsense syllables, the visual mode alone or even in combination with other modes tended to be more effective than the auditory mode. Similarly, in 1967, Cooper and Gaeth (5) found that fourth graders used the visual modality more effectively than the auditory modality with nonsense syllable

paired-associates. Hawkins's fourth graders had found that, with words, the auditory modality was more effective.

Similarly for fifth graders, Cooper and Gaeth found the visual mode more effective for nonsense syllables while Hawkins found the auditory mode more effective for words.

In 1928, Russell (22) found that the auditory mode was more effective for his group of seventy-two fifth graders when they were tested on the contents of a 1000 word essay on the Mongoose. However, Russell's seventh graders used both modes equally well, and his ninth graders found the visual more effective. A factor which may have been significant here is the readability of the essay. Reading skill rather than the mode may have contributed to the increasing effectiveness by age of the visual mode.

Walters and Kosowski (25), in 1963, found that, for fifth, sixth, and seventh graders, the visual presentation of colored lights was more quickly responded to than was the auditory presentation of non-verbal tones. Similarly, in 1965, Many (16) found that sixth graders scored higher on visually presented questions about visually presented material than they did on orally presented questions about orally presented material. Lockhard and Sidowski (15), however, found that there was no significant difference between the two modalities for their sixth graders in the learning of lists of nonsense syllables.

On the whole, examination of comparisons of single modalities among children indicates that the evidence leans somewhat in the direction of the greater effectiveness of the visual modality, although consensus has by no means been reached.

A second category of studies of the modalities deals with the question of whether the simultaneous use of more than one modality is more effective than using one modality alone. Starting with the

earliest studies, attempts have been made to compare the results of learning through audio-visual or other modality combinations. Frequently, the kinesthetic or motor modality in various forms has been part of such combinations.

The question of using more than one modality at the same time is of particular importance for beginning reading instruction. It is then, when the prime task is to transpose aural language to written forms, that understanding the relative effectiveness of using more than one modality to help in this task is essential. A number of reading methods have focused upon the simultaneous use of more than one modality. Fernald's technique is an obvious example of this use. In addition, using writing or discouraging writing in the development of word recognition skill and requiring oral reading before silent reading or vice versa are techniques which, whether the practitioners are aware of it or not, are based upon assumptions about the value of the simultaneous use of more than one modality.

In the study reported above, Münsterberg (17) found that when his colors and numbers were simultaneously displayed and named aloud, there was an enormous decrease in the average number of errors made. Quantz (21), in investigating whether persons who are distinctly visile are more rapid or more intelligent readers than those who are distinctly audile, found that adding the motor modality by having such subjects read the one syllable words aloud was a hindrance.

O'Brien (18) used ten types of sensory mode--the auditory and the visual and eight combinations of two, three, or four simultaneous modes. So many combinations were possible because he identified the "vocimotor," or articulating, and the "manumotor," or writing, as two separate motor modes, and then proceeded to make combinations such as visual-auditory-manumotor and auditory-

vocimotor-chanumotor. Actually, other studies had used some of these combinations (Whitehead (26) for example) but had not focused on which modalities were actually being used and some erroneously referred to their findings as if they were based on purely auditory or purely visual modes when simultaneous use of another mode had been in operation at the time. Unfortunately, as O'Brien himself noted, it was difficult to bring subjective factors under control in his study, but he did report that the visual-vocimotor was the most effective by far of his ten modes.

Krawiec (14) in 1946 concluded that "the visual mode of presentation is especially adapted for the learning of difficult verbal material," defining nonsense syllables and unrelated nouns as difficult verbal material. However, he required his undergraduate subjects to pronounce and spell aloud each syllable for the visual task, while the auditory task involved just listening to the items read aloud. His results obviously relates to a visual-vocimotor mode rather than to the visual mode, and actually affirm the greater efficiency of this plural modality.

Far too rarely in modal investigati;ns has there been any reference to models of the perceptual system or of brain functioning. While we may assume that in many instances the investigator had some such model in mind, it is difficult to reconstruct it with certainty. In addition, some investigators have hypothesized without reference to any model at all. One of the few investigations which clearly relate to a perceptual model is that of Van Mondfrans and Travers (24) who outlined their understanding of Broadbent's thinking. They stated that Broadbent conceived of the perceptual system as a single system. This implied that at any one time, only input from a single channel has access to higher centers of the brain. The inputs entering from other sensory channels at that

time are stored (for a few seconds) until the channel to the higher centers is free. Only then can the inputs that were briefly stored pass through. When an input does not gain access, it is lost. From this, Van Mondfrans and Travers reasoned that multiple channel inputs of the same information ought not to facilitate learning. They hypothesized, however, that perhaps if enough time elapses during inputs, the learner can switch from one sensory signal to another and hence increase learning by having, in effect, an extra trial. To study this time factor, they designed two experiments in which single modality and dual modality stimuli were presented at four different durations: four seconds, two seconds, one second, and .6 second. Each of three groups of twenty-four under-graduates was presented with a list of either nonsense syllables, unconnected words, or words in meaningful groups of four. The visual presentation was on tape. An audio-visual presentation was presumably simultaneous.

The results indicate that for learning words, connected or unconnected, there was no significant difference between any of the modes. For learning nonsense syllables, the auditory mode was significantly inferior to both the visual and the audio-visual, while there was no significant difference between the visual and the audio-visual modes. Strangely, although the authors reported the fact that the visual presentation lasted a good deal longer, apparently, than the auditory presentation (at some stages, as much as two to four seconds longer), they do not refer to the longer visual exposure time as a possible factor in the superiority of the visual mode.

Later, in 1966, Jester and Travers (10) found, in presenting eight passages of the Davis Reading Test to undergraduates, that although the auditory mode was superior at the lower rates of presentation, and the visual mode was superior at the highest rates, the audio-visual presentation was superior to either of

these single modes for learning efficiency as well as for test item performance. The authors reason that perhaps this greater efficiciency of the dual mode is due to the fact that with two modalities from which to choose, individuals with modal preferences can utilize the mode of choice.

Lockhard and Sidowski (15) also compared single and plural modalities and found that when writing was added as a task after either visual, auditory, or visual-auditory stimulus presentati;n, their fourth graders did better. Their sixth graders did better when they did not use writing.

The third category of modality studies includes those that were designed specifically to focus on reading, although all of the studies, except those using only pure tones, lights or pictures, required some form of reading ability, even if only in the form of decoding CVC trigrams.

One of the first to investigate modality and reading was Quantz (21) in 1897, who concluded from his investigation with adults that visual perception should be placed above practice, concentration, intelligence, and academic proficiency as a contributing factor to rapid reading.

Otto investigated modes of learning and reading achievement among children, examining variables which he stated had not been checked in earlier studies. Intelligence, the relationship between mode of reinforcement and reading achievement, and the interaction of grade placement with reading level for mode of reinforcement were reported upon in his 1961 (19) and his 1963 (20) studies. In both studies, he used paired associates (geometric forms and CVC trigrams) and presented them with either auditory, visual-auditory or kinesthetic-visual-auditory reinforcement. In the

1961 study he identified the good, average, and poor readers among 108, average IQ, second, fourth, and sixty graders and tested each subject in turn, using one of the three modes of reinforcement. Results indicated that the lower the grade, the more trials were necessary in order to learn the paired associates. Also, good, average, and poor readers, in that order, needed more trials for learning. Mode of reinforcement interacted significantly with grade level, so that the k-v-a was more effective for second graders, the v-a was more effective for fourth graders, and both these modes were about equal for sixth graders. There was not, however, significant interaction between mode of reinforcement and reading level. When retention of what was learned was tested, it was found that good and poor readers retained what was learned equally well. In his 1963 study, Otto used the same task and modes of reinforcement as in the 1961 study. Now, however, he wished to investigate whether poor readers learned the paired associates more slowly because they had poorer sensory discrimination for the stimulus items or because they had greater difficulty in reading the CVC trigrams. He used thirty poor readers in grades four through seven, with IQ scores ranging from 92 to 129, and examined their ability to discriminate the geometric forms and the trigrams as well as to read the trigrams.

He found that neither poor discrimination nor poor reading of the trigrams were significant. In addition, scores resulting from administering the learning tasks to the subjects indicated that there was no significant difference between the modes of reinforcement, a finding contradictory to the findings of his 1961 study. Otto suggested that manipulating IQ as a variable in a larger study might lead to an explanation for the contradiction.

In 1963, In Canada, Walters & Kosowski (25) also studied the

modal responses of good, average, and retarded readers, using seventy-two sixth, seventh, and eighth graders with "no emotional or behavior problems" or hearing or vision anomalies. The stimuli were non-verbal pure tones and colored lights, to eliminate the variable of reading. The subjects were divided into two groups matched for age, grade, and reading/intelligence discrepency scores. In addition to comparing the speed of response to the visual and auditory stimuli, the investigators were interested in the reward/non-reward variable, and told one group that they would be rewarded for successful efforts. Results indicated that, in the auditory task, rewarded retarded readers did as well as the good and average readers in the other groups and significantly better than non-reqarded readers. There were no significant differences in speed of reaction to the visual task.. Walters and Sidowski concluded that "retarded readers need an incentive in relatively difficult learning situations and also that, unless highly motivated, retarded readers tend to be less attentive to stimuli." Further, difficulties in learning may, therefore, be partly a function of a reduced ability to attent to stimuli. For their total sample, Walters and Sidowski found that there was a highly significant transfer effect when change was made from one mode of presentation to another, whether it was the auditory or the visual mode which came first. They reasoned from this finding that "once the general nature of the symbolic learning problem is understood, the principles involved can be generalized to somewhat similar situations to facilitate the learning process."

In 1963 in New York City, Katz and Deutsch (12), using forty-eight first, third, and fifth graders, compared average, high reading achieving Negro boys (97.9 mean IQ), with low reading

achieving Negro boys (82.1 mean IQ) for cross-modal reaction time and for same or "ipsi"-modal reaction time to pure tone and colored lights stimuli. They found that the relation between mode of stimulation and reading level was not significant. However, they found that, although there was a decided trend for all subjects to have greater difficulty in shifting from one modality to another, the retarded readers had significantly greater difficulty than did the normal readers. These findings concerning modal shifting are contradictory to the findings reported by Walters and Sidowski, and may perhaps be accounted for by the differences in the subjects of the two studies (age, intelligence, and possibly, socioeconomic background).

In 1965, Birch and Belmont (2) investigated the auditory-visual integrative ability of 220 children (120.3 mean IQ) from kindergarten through sixth grade by having the subjects match an auditory pattern which had been made by a pencil tapping with a similar pattern transposed into dots. A correlation of .56 was found between IQ and auditory-visual integration and of .70 between reading readiness and auditory-visual integration. It was noted by the authors that the task tended to approach an asymptote after age seven as the scores for the shildren tended to level off, and that therefore more data was needed in this area. However, they concluded that the findings suggested that "primary perceptual factors may be most important for initial acquisition of reading skill, but factors more closely associated with IQ are more important in its elaboration."

Katz (11) came to a similar conclusion in 1967. Although the primary purpose of her study was to check on the role of stimulus familiarity in the relation between discrimination and

reading performance, there was also a comparison made between the auditory and visual discrimination performances of normal and retarded readers of different ages. Her seventy-two subjects were second, fourth, and sixth grade Negro boys from low socio-economic backgrounds separated into good and poor readers. Monosyllabic three-letter word pairs in English and in Hebrew were presented visually on slides and auditorily on tape. The subjects were asked to tell whether the words in each pair were alike or different. Results indicated that for the total sample, the visual modality was more effective with the familiar English words, while the auditory modality was more effective with the unfamiliar Hebrew words. Katz notes that this finding is contradictory to the findings of Budoff and Quinlan (3), and suggests that either the task differences or the population differences in the two studies may account for this contradiction. It was also found that while older children and better readers at each grade level were better discriminators, the "differences in discrimination performance between good and poor readers at the second-grade level were significantly greater than differences at the fourth and sixth-grade levels." This leads Katz to suggest that while deficient perceptual skills may be very important as factors in reading disability at earlier stages of reading instruction, a deficiency in cognitive abilities may be more significant at maintaining reading disability during the middle elementary grades. This suggestion is similar to the conclusion of Birch and Belmont (2) noted above.

In 1967, Rudnick, Sterritt, and Flax (23) investigated the ability of thirty-six above average IQ third grade boys to transfer to visual dot patterns the auditory patterns of Birch and Belmont's pencil-tapping test, the auditory patterns of tape-

recorded tones, and the visual patterns of blinking lights. They suggested that, as a result of this and related investigations "visual perceptual abilities decline in importance from third to fourth grade, while general intelligence and auditory and/or cross-modal perceptual abilities become more important in relation to individual differences in reading ability as the child moves from third to fourth grade."

In this paper, three groups of modality studies were categorized. Brief descriptions of each investigation were given, and pertinent results and conclusions were summarized. An attempt was made to collate frequently cited studies from a variety of sources in order to indicate the historical and conceptual scope of this area of research.

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